Module 8 Lab Activity: Matrix Algebra and Multivariate Correlations

PSY 652 Research Methods

Oct 21, 2020

This activity is designed to give you some hands-on practice with basic skills in matrix algebra.

I suggest using the following resources for this activity:

1. Module 8 lecture slides and the R notebook that accompanies the Murphy, *In Press* reading.
2. This "Math is Fun" webpage provides a nice overview of what you're actually *doing* when you multiply matrices: https://www.mathsisfun.com/algebra/matrix-multiplying.html
3. Quick-R: provides a dictionary of commands in the base R package that are used for matrix algebra in R: https://www.statmethods.net/advstats/matrix.html

Relevant syntax:

%*% is the command for multiplying two matrices
matrix(c()) is the function for creating a matrix
t() is the function for transposing matrices
matrix_name[rows,columns] is how you index variables

1. Create a new R notebook titled "Matrix Algebra Practice"
2. For this assignment, you will be working with the following matrix:

	X1	X2	X3	Y1	Y2
X1	1.000	0.448	0.485	0.425	0.555
X2	0.448	1.000	0.333	0.283	0.423
X3	0.485	0.333	1.000	0.266	0.337
Y1	0.425	0.283	0.266	1.000	0.111
Y2	0.555	0.423	0.337	0.111	1.000

3. Create a first level header: "Step 1: Define the number of X & Y variables"
    a. In a new R chunk:
        1. Create an object called "nx" which contains the number of X variables in your matrix
        2. Create an object called "ny" which contains the number of Y variables in your matrix
            1. *You will use these values later when indexing your correlation matrix*
4. Create a first level header: "Step 2: Add in calculations to help R identify start & end points"
    a. In a new R chunk:
        1. Create an object called "ntot" which is the sum of your nx & ny variables
        2. Create an object called "firsty" which is nx + 1
            1. *You will use these values later when indexing your correlation matrix*
5. Create first level header: "Step 3: Enter the weights for the criteria (Y variables) and test (X variables) variables
    a. In a new R chunk:

1. Create an object called “Cweight” which is a matrix containing the weights two weight values of 1.0
    1. *Hint: Cweight<-matrix(c(1.0,1.0),ncol=1,byrow=T)*
2. Create an object called “Tweight” which is a matrix containing the weights three weight values of 1.0
    1. *Hint: Tweight<-matrix(c(1.0,1.0,1.0),ncol=1,byrow=T)*

6. Write a first level header: “Step 4: Create the matrix”
    a. In a new R chunk, copy and paste the following code to create a matrix

```
Cormat<-matrix(c(
  1.00,.448,.485,.425,.555,
  .448,1.00,.333,.283,.423,
  .485,.333,1.00,.266,.337,
  .425,.283,.266, 1.00,.111,
  .555,.423,.337,.111,1.00),
  ncol=5, byrow=TRUE)
```

7. Write a first level header: “Step 4.1: Separate the matrix into its corresponding parts”
    a. In a new R chunk:
        1. Create a new object called “Rxx” which indexes all of the X correlations from the Cormat object.
            1. *Hint: Rxx <- Cormat[1:nx,1:nx]*
        2. Create a new object called “Ryy” which indexes all of the Y correlations from the Cormat object.
            1. *Hint: Ryy <- Cormat[firsty:ntot,firsty:ntot]*
        3. Create a new object called “Rxy” which indexes all of the XY correlations from the Cormat object.
            1. *Hint: Rxy<-Cormat[1:nx,firsty:ntot]*
8. Write a first level header: “Step 5: Calculate the multivariate statistic”
    a. You will now calculate the following equation:

$$R_{CxCy} = \frac{w_x R_{xy} w_y'}{\sqrt{w_y R_y w_y' \sqrt{w_x R_x w_x'}}}$$

    b. In a new R chunk:
        1. Transpose your Cweight matrix and save it to a new object called “CweightT”
        2. Transpose your Tweight matrix and save it to a new object called “TweightT”
        3. Calculate the numerator of the equation and save it into a new object called “numer”
            1. *Hint*: Transposed X weights * Correlations of XY * Y weights(Non-transposed)
        4. Calculate the denominator of the equation

        1. First, multiply the Y matrix by its weights and name it an object called “vary”
            1. Vary <- CweightT %*% Ryy %*% Cweight
        2. Next, multiply the X matrix by its weights and name it an object called “varx”
            1. Varx <- TweightT %*% Rxx %*% Tweight
        3. Lastly, take the square root of each object and multiply them. Save it to an object called “denom”
            1. This is the denominator of your equation
    5. Get the multivariate correlation by dividing the numerator by the denominator (numer / denom).
9. You should get a value of .652879
10. In the white space, explain what this value means.
11. Turn in your R notebooks html file